Fundamental understanding of technetium interactions in the environment of nuclear waste repositories

Natalia Mayordomo[1], Diana M. Rodríguez[1], Vinzenz Brendler[1], André Rossberg[1,2], Dieter Schild[3], Katharina Müller[1]

[1]Helmholtz-Zentrum Dresden – Rossendorf, Institute of Resorce Ecology, Bautzner Landstrasse 400, D-01328 Dresden, Germany

[2]The Rossendorf Beamline (BM20), European Synchrotron Radiation Facility, B.P 200, F-38043 Grenoble Cedex, France

[3]Karlsruhe Institute of Technology (KIT), Institute for Nuclear Waste Disposal (INE), Hermann-von-Helmholtz-Platz 1, D-76344, Eggenstein-Leopoldshafen, Germany

Technetium (Tc) is an element of concern for the environment and living organisms. In particular, ^{99}Tc – a beta emitter with a long half-life ($t_{1/2} = 2 \cdot 10^5$ years) – is the most abundant isotope of Tc. Besides its medical applications, it is generated during energy production in nuclear reactors and must be considered in the safety assessment of nuclear waste repositories. Tc is known to be very mobile in water fluxes under aerobic condition, when mainly Tc^{VII} is present. Tc^{VII} barely interacts with minerals or microorganisms that could restrict its migration. Thus, the strategy to immobilize Tc^{VII} employs the reduction of Tc^{VII} to Tc^{IV}, since the main species of Tc^{IV} is a low soluble oxide ($Tc^{IV}O_2$), limiting Tc migration through aquifers. The change in redox state is triggered by reducing agents, such as Fe^{2+}, sulfide or by microbiological redox cascades. Thus, it is necessary to evaluate the interaction of Tc with different materials present in engineered or natural environments also under more complex experimental conditions. We use a broad variety of advanced techniques along a value chain that starts with determination of thermodynamic data (*i.e.* complex formation constants, solubility constants of minerals, redox potentials and Tc distribution coefficients) it is followed by structural verification by micro-spectroscopy approaches up to establishment in thermodynamic databases**.** Our particular interest is the *in situ* monitoring of molecular sorption and redox processes at biogeochemical interfaces and in solutions. As a result, a deep chemical understanding of environmental behavior of technetium will allow the development of sound risk assessments and remediation strategies. This is only feasible by a multidisciplinary approach, including chemistry, geosciences and microbiology.

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